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MEMORANDUM FOR PRS (In-House Publication)

FROM: PROI (STINFO) 22 May 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-VG-2002-125**
C.T. Liu (PRSM) and J.N. Yang (UCI), "Investigating the Strain Rate Effect on the Critical Inherent Crack Size in a Particulate Composite Material"

4th Int'l Conf on Statistical Mechanics **(Statement A)**
(Corfu, Greece, 9-13 June 2002) (Deadline = 29 May 2002)

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PHILIP A. KESSEL Date
Technical Advisor
Space and Missile Propulsion Division

Investigating the Strain Rate Effect on the Critical Inherent Initial Crack Size in a Particulate Composite Material

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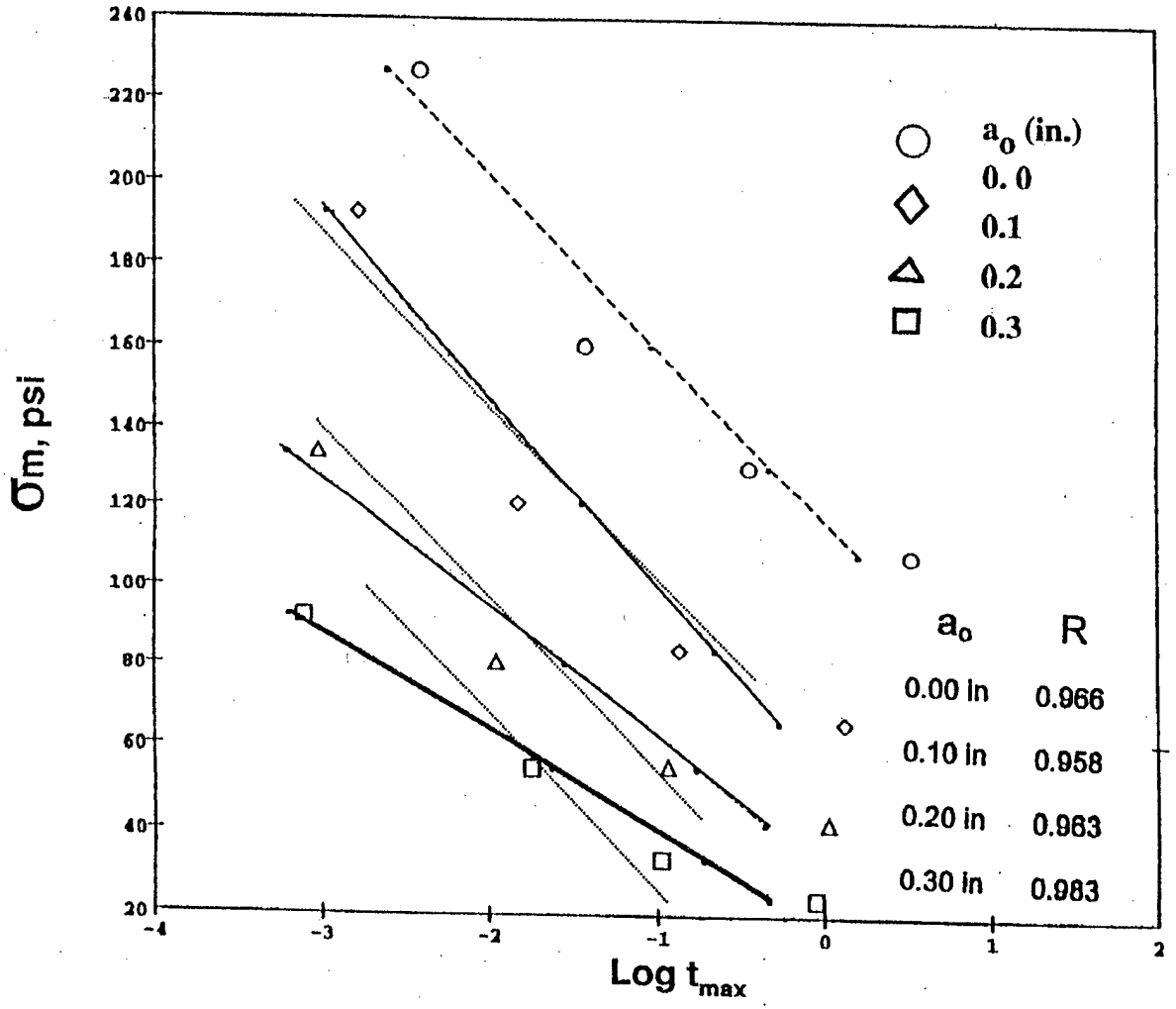
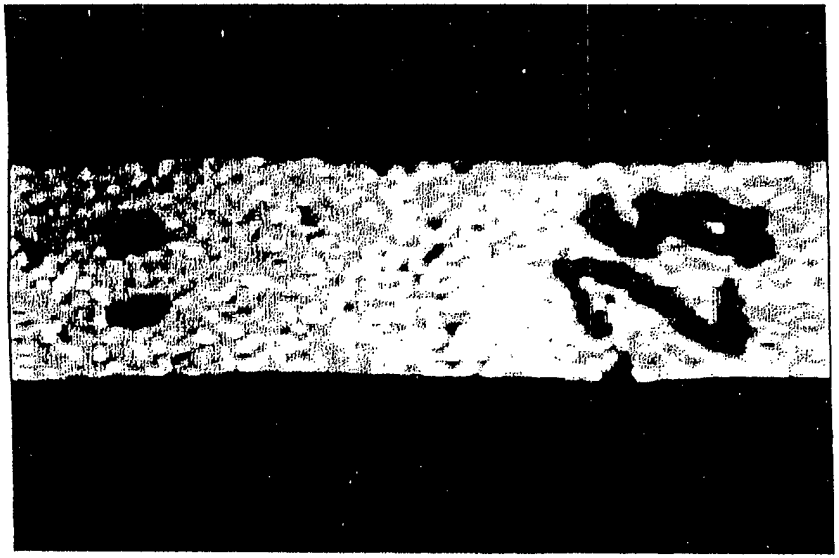
Objectives

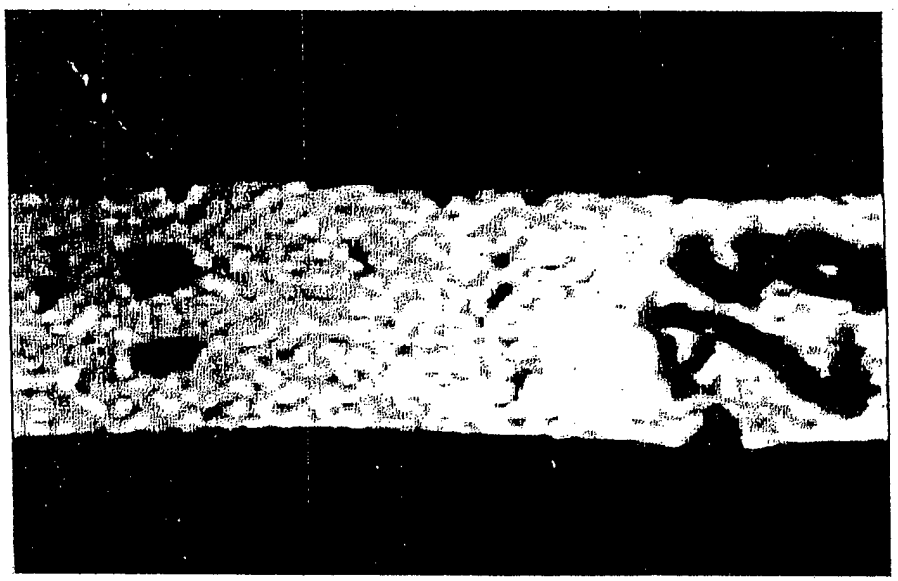
- Investigate the Effect of Strain Rate on the Critical Inherent Crack Size in a Particulate Composite Material
  - Strain Rates: 0.727 In/in/mm. 18.18 In/in/mm
- Determine the Statistical Distribution Function of the Critical Inherent Crack Size
  - Normal Distribution
  - Two-Parameter Lognormal Distribution
  - Two-Parameter Weibull Distribution
  - Second Asymptotic Distribution of Maximum Value

Maximum Stress Versus Maximum Time



Cracked Specimen
(Displacement Rate = 50 in/min)





Distribution Parameters for Normal, Two-Parameter Lognormal, Two-Parameter Weibull, and Second Asymptotic Distribution of Maximum Value

- **Displacement Rate = 50 in/min**

Mean μ (in.)	0.15750	0.14735	0.14597
Standard Deviation σ (in.)	0.00290	0.00296	0.00290
Coefficient of Variation $\nu = \sigma/\mu$	0.01843	0.02008	0.01989
$\mu^* = \ln [\mu /(1+V^2)^{1/2}]$	-1.84850	-1.91515	-1.92455
$\sigma^* = [\ln(1+V^2)]^{1/2}$	0.01843	0.02008	0.01989
α	53.6679	49.6042	50.0732
β	0.1590	0.1488	0.1474
κ	51.3792	47.7947	48.4204
ν	0.1559	0.1458	0.1444

Distribution Parameters for Normal, Two-Parameter Lognormal, Two-Parameter Weibull, and Second Asymptotic Distribution of Maximum Value

- **Displacement Rate = 2 in/min**

	a_c	a^*	a_0
Mean μ (in.)	0.12999	0.12131	0.11865
Standard Deviation σ (in.)	0.00152	0.00159	0.00157
Coefficient of Variation $V = \sigma/\mu$	0.01172	0.01315	0.01324
$\mu^* = \ln [\mu /(1+V^2)^{1/2}]$	-2.04037	-2.10949	-2.13166
$\sigma^* = [\ln(1+V^2)]^{1/2}$	0.01172	0.01315	0.01324
α	80.1490	74.4797	74.4295
β	0.1308	0.1221	0.1194
κ	72.4144	70.8220	71.9862
ν	0.1291	0.1204	0.1178

Summary of Crack Lengths
(Displacement Rate = 2 in/min)

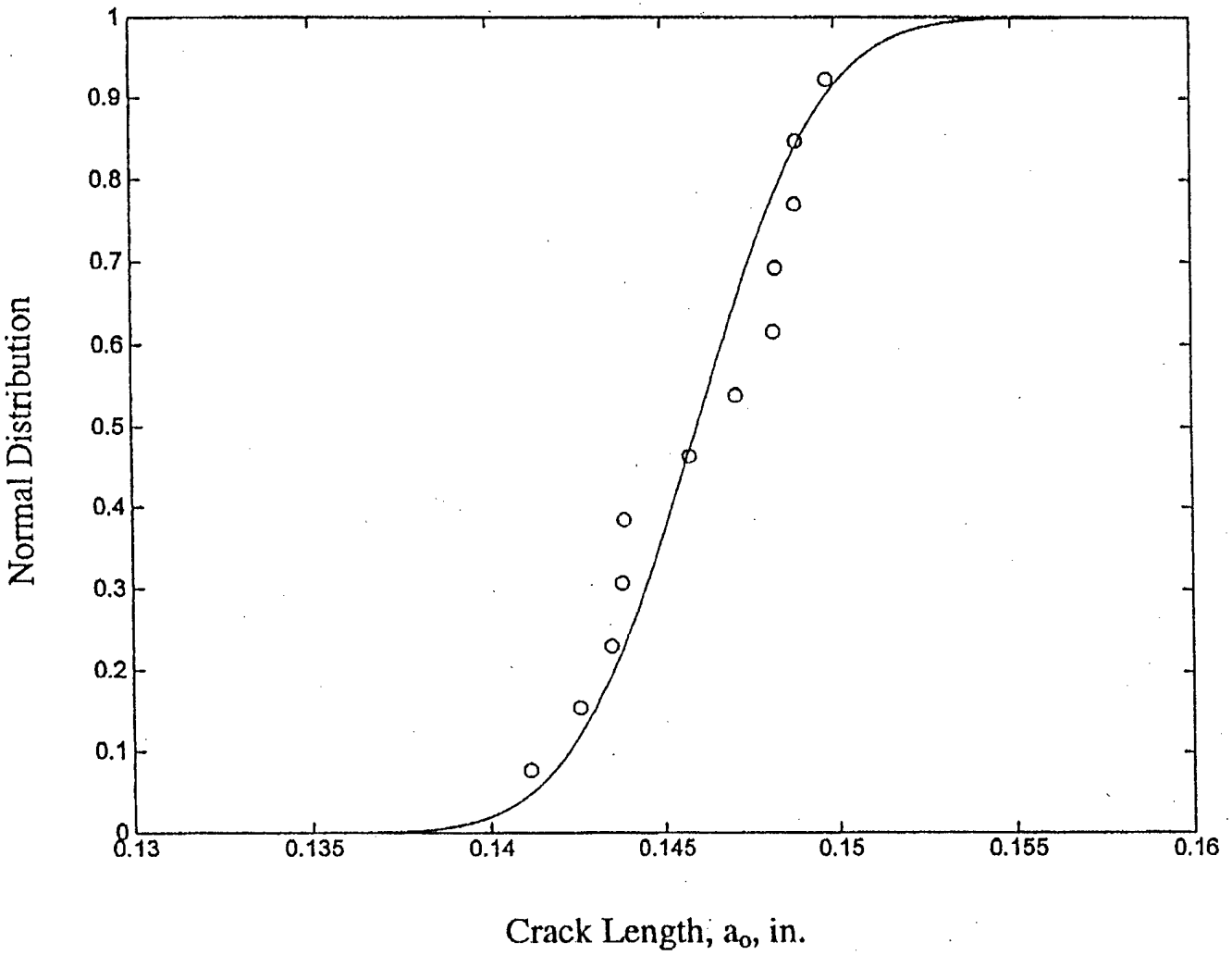
	a_c	a^*	a_0
Specimen 1	0.12965	0.12968	0.11793
Specimen 2	0.12964	0.12030	0.11753
Specimen 3	0.12918	0.12052	0.11790
Specimen 4	0.12966	0.12046	0.11778
Specimen 5	0.12608	0.11785	0.11545
Specimen 6	0.13168	0.12287	0.12012
Specimen 7	0.13145	0.12338	0.12084
Specimen 8	0.13069	0.12171	0.11902
Specimen 9	0.13057	0.12281	0.12029
Specimen 10	0.13100	0.12256	0.11988
Specimen 11	0.13029	0.12124	0.11846

a_c is the critical crack length, a^* is the predicted critical inherent crack length based on the K_{-} [illegible] and a_0 is the predicted critical inherent crack le

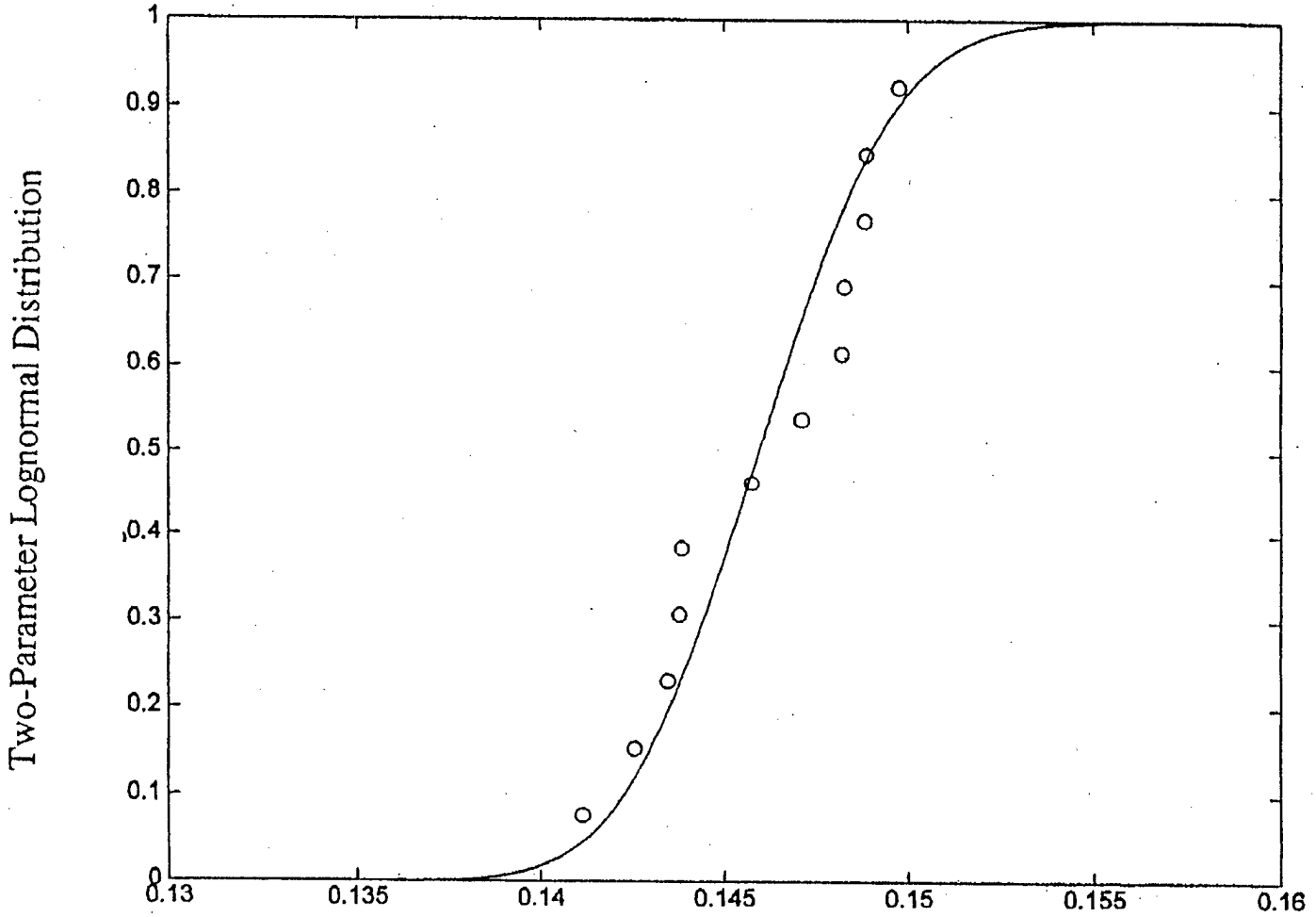
Summary of Crack Lengths
(Displacement Rate = 50 in/min)

	a_c	a^*	a_0
Specimen 1	0.15425	0.14396	0.14258
Specimen 2	0.15425	0.14396	0.14258
Specimen 3	0.15543	0.14530	0.14386
Specimen 4	0.15993	0.15018	0.14888
Specimen 5	0.15268	0.14237	0.14114
Specimen 6	0.15476	0.14506	0.14379
Specimen 7	0.15505	0.14471	0.14348
Specimen 8	0.15073	0.15029	0.14883
Specimen 9	0.16006	0.14973	0.14826
Specimen 10	0.15765	0.14717	0.14575
Specimen 11	0.15902	0.14858	0.14711
Specimen 12	0.16086	0.15115	0.14976
Specimen 13	0.15963	0.14965	0.14819

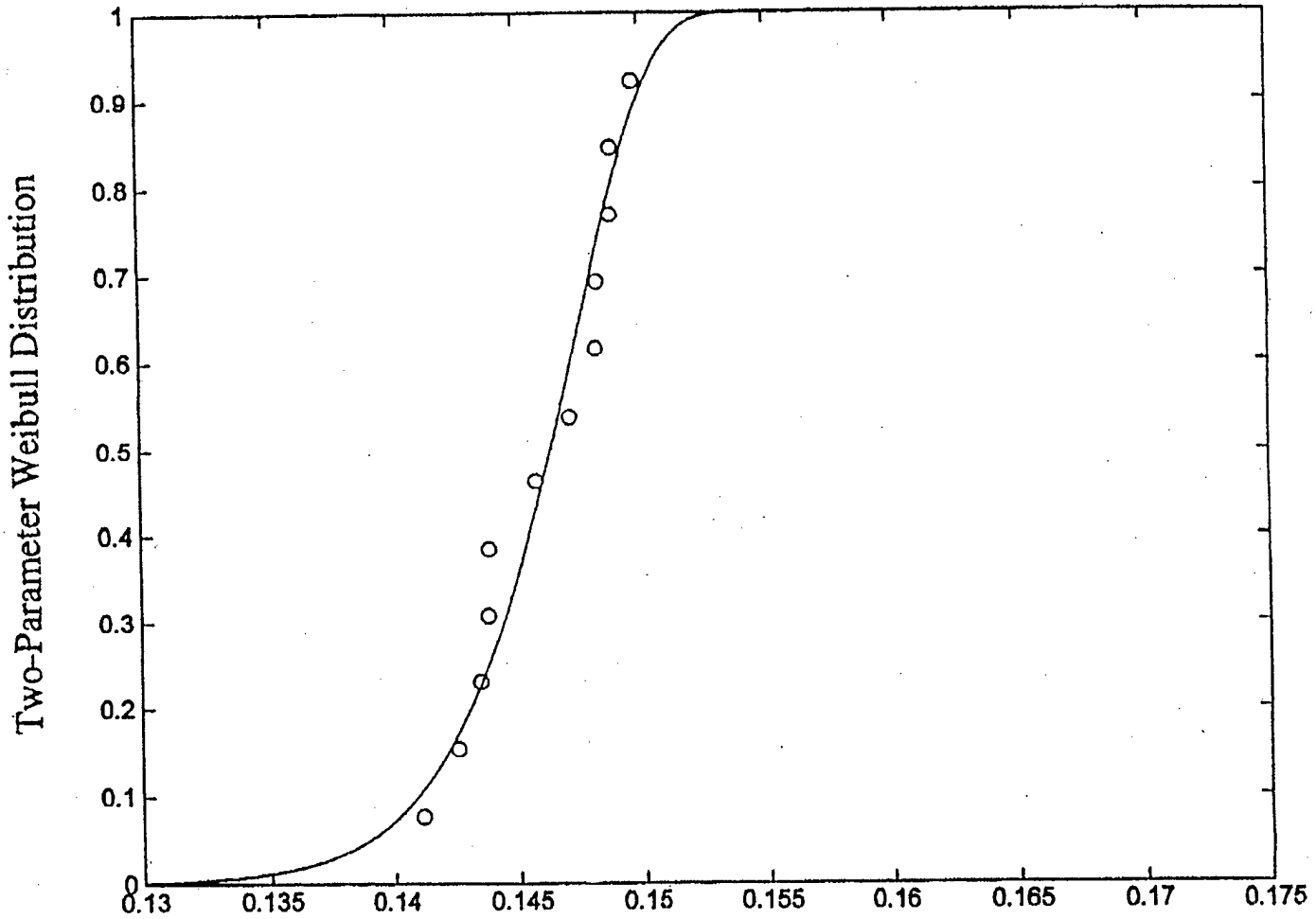
Normal Distribution Plot for a_o



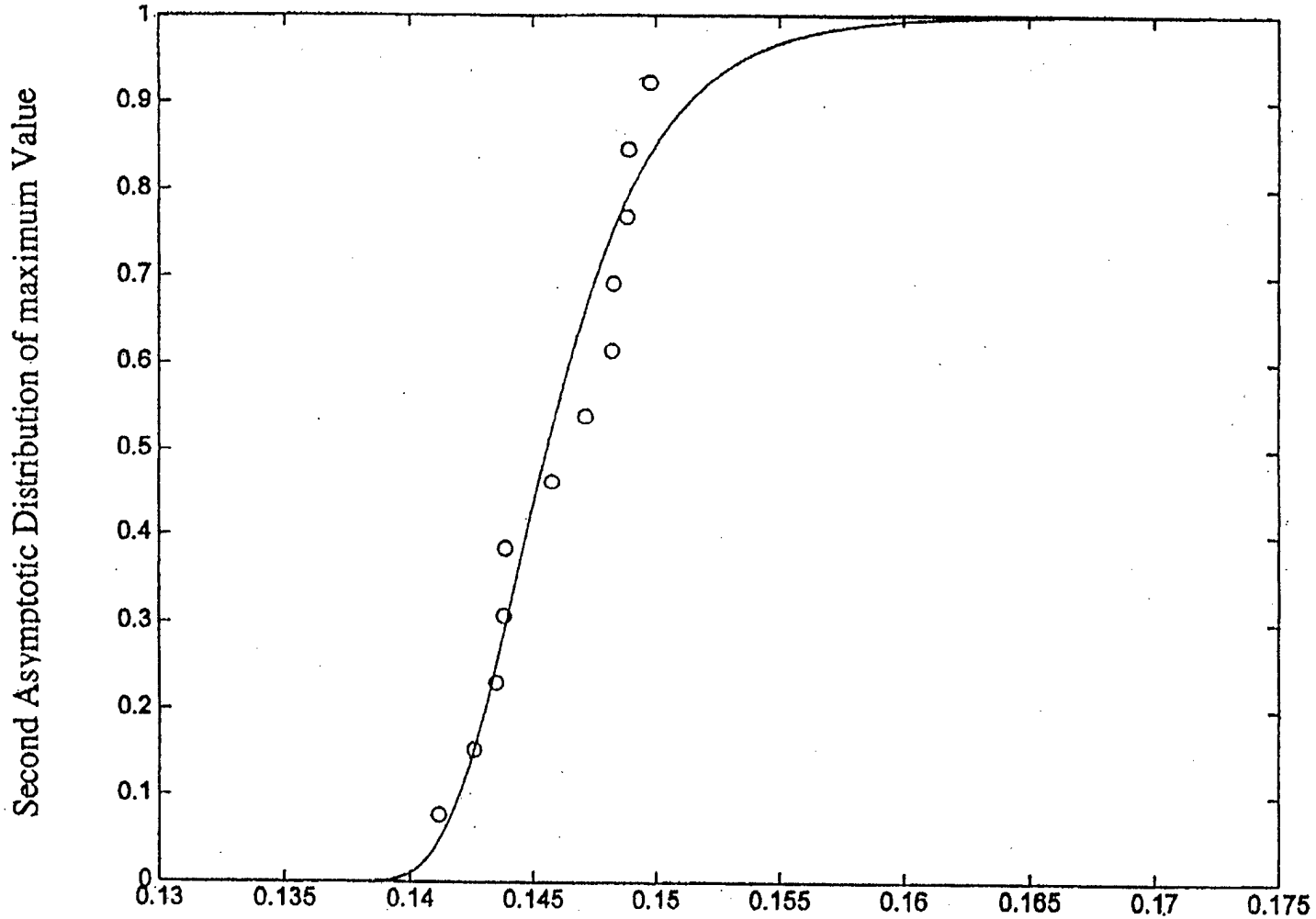
Two-Parameter Lognormal Distribution Plot for a_o



Two-Parameter Weibull Distribution Plot for a_o



Second Asymptotic Distribution of Maximum Value Plot for a_o



Conclusions

- For the material studied, strain rate has no significant effect on the critical inherent crack size
- The predicted average critical inherent crack size is 0.132, which compares well with experimental value
- The critical inherent crack size follows the Two-Parameter Weibull Distribution